ON THE RELATION OF ANTICYCLONIC WEATHER TO THE PREVALENCE OF LA GRIPPE AND PNEUMONIA ON THE NORTHERN HEMISPHERE WITH SPECIAL REFERENCE TO RECENT EPIDEMICS OF PNEUMONIA IN CHICAGO AND SAN FRANCISCO. *

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The report of the pneumonia commission of New York,[1] issued end of 1905, contains the words: "Our studies have thrown no light whatever upon the conditions, which determine the onset of lobar pneumonia in apparently healthy persons. Moreover, we have been unable to draw conclusions as to the presence of pneumococci in the lungs during life, or as to the channels by which they gain access thereto." The United States Census report of 1900 says: "The very fact of an increasing mortality from pneumonia in late years, when general hygienic conditions have steadily improved, would disprove the efficiency of such a course of prophylaxis."

Juergens[2] in a résumé of the latest research work on pneumonia refers to the attempts made most recently to discover a positive difference between the pneumococcus of a healthy mouth and that of the pneumonia mouth and asserts the absolute failure to establish a specific character for the pneumococcus of pneumonia.

Where there is still so much darkness I hope you may pardon me for drawing your attention to certain conditions of the atmosphere, which accompany pneumonia epidemics over the entire northern hemisphere, and where San Francisco seems to give the key to knowledge.

Osler[3] says that "cold" has been for years regarded as an important etiological factor, but that in fact there is very little difference in various state groups of the United States.

Musser and Norris[4] referring to meteorological influences, say that "owing to the complexity of the problem, an exact scientific solution of it is still unattained." They add: "Most writers have attributed a predisposing potency to change of temperature."

During the last meeting of the American Medical Association at San Francisco, June 5-8, 1894, I read a paper[5] on the influence of atmospheric pressure on the prevalence of pneumonia. I maintained then, that excessively high air pressure appears coincident with epidemics of pneumonia in the northern hemisphere and exhibited charts demonstrating this fact for a number of cities. That paper had been made possible by a study of the different climatic regions of California in their relation to morbidity and mortality from pneumonia.

As so-called "cold weather diseases" were prevalent in California, but the cold weather missing, I charted all the different meteorological factors and the pneumonia mortality figures together for a number of years for the different climatic regions of California, and could thereby establish the fact, that, at least everywhere in California, in the Sierra as well as near the sea coast, there was absolutely no relation between temperature and humidity and such mortality, but clearly so between periods of high air pressure and such mortality.

One may consider San Francisco as the city par excellence to make a research in regard to the influence of weather on disease.

There is hardly any other large city to be found on the northern hemisphere with as little difference between the mean temperature and mean relative humidity of January and July.

NORMAL AIR PRESSURE.

	Jan.	Feb.	Mar.	Apr.	May	June
Chic.	30.09	30.07	30.02	29.99	29.96	29.95
S. F.	30.11	30.10	30.06	30.05	29.99	29.95
	July	Aug.	Sept.	Oct.	Nov.	Dec.
Chic.	29.98	29.99	30.04	30.04	30.06	30.08
S. F.	29.95	29.93	29.94	30.01	30.08	30.12

NORMAL TEMPERATURE.

	Jan.	Feb.	Mar.	Apr.	May	June
Chic.	23.4	26.8	34.1	45.6	56.1	66.7
S. F.	50.1	51.7	53.6	54.6	56.6	58.4
	July	Aug.	Sept.	Oct.	Nov.	Dec.
Chic.	72.0	70.9	69.2	52.0	38.4	29.3
S. F.	58.3	58.7	60.4	59,3	56.3	51.4

NORMAL RELATIVE HUMIDITY.

	Jan.	Feb.	Mar.	Apr.	May	June
Chic.	81	81	75	71	70	72
S. F.	79	77	78	78	78	79
	July	Aug.	Sept.	Oct.	Nov.	Dec.
Chic.	67	68	69	69	77	79
S. F.	83	85	80	79	75	81

Extreme winter and summer temperatures and extreme cloudiness may justly be eliminated in San Francisco. The lowest temperature in Chicago is—23, in San Francisco 29, a difference of 52 degrees. On the other hand, San Francisco could easily take the laurels from Chicago as "the windy city, in summer time. In San Francisco ocean winds are prevailing during 9 months of the year. Of course it gets ocean sand with them, which we call sometimes an abominable dust. The prevailing wind of Chicago is S. W. but during five months it is N. E., coming from the lakes. San Francisco has not been a densely populated city, like Chicago, and enjoys a rather pure ocean atmosphere, very different from the air inhaled in Chicago, New York, London, Paris or Berlin.

It is the presence of the Pacific Ocean and the westerly direction of the winds that insures high winter and cooler summer temperatures for San Francisco. Even Chicago's winter temperatures are somewhat ameliorated by the large area of fresh water near it.

San Francisco has an average of 69 rainy days in the year and Chicago has 126. The percentage of possible sunshine is 57% for Chicago and 63% for San Francisco.

It will impress you deeply, when you study this second chart before you, giving the even temperature and humidity line for San Francisco for every day of the 11 years 1888 to 1899, in contrast to the lines of pneumonia mortality and air pressure.

These facts prompted me to make and to put before you a study of the pneumonia epidemics of Chicago and San Francisco for the 5 years 1899 to 1904, in their relation principally to air pressure.

* Read before the San Francisco County Medical Society, March, 1908.

Meteorological observations and figures take the place of experiments, where periodical changes in the atmosphere and their effect on climate are to be investigated. Such research work should be more encouraged.

A fundamental difference between low and high air pressure, that is between cyclones and anti-cyclones, lies in the fact that during the cyclone the lower air, the ground air, the air that had been with us since the last anticyclone, is ascending into the upper atmosphere, whilst during an anticyclone the reverse takes place; the air is coming down from the higher levels of the atmosphere.

The anticyclone is represented by a gyration of air that enters at the top and flows out at the bottom. The air is descending almost vertically in the center and shows an outward flow everywhere in the circumference of the anticyclone. The distance of the center of an anticyclone from that of a cyclone is generally about 2000 miles in the United States and often more than that in Europe. It is not so very seldom that the entire area of the United States is covered by an anticyclone.

The cyclones travel at the rate of 20 to 60 miles an hour, the anticyclones show a similar speed, which is, in fact, the speed of our railroad trains and which is the speed with which la grippe epidemics are said to travel.

Suppose that an anticyclone has its center at half distance between Chicago and San Francisco, then it is clear that some of its center air may travel at this rate 1000 miles towards San Francisco and some of it 1000 miles towards Chicago. It is at present assumed that the so-called "wandering" cyclones are rather shallow, extending only about 2-3 miles upward. They are not supposed to feed the anticyclones with their air, as the anticyclones extend higher up.

The continuous procession of such areas of low and high air pressure from a westerly to an easterly direction in our latitudes furnish the rainstorms and the fine weather periods during the so-called cold season.

The anticyclones sometimes stop their wandering tendency. Such anticyclones seem to have a dynamic, not a thermic origin, like the rest of them. They represent a blocking of the higher and lower atmosphere and it seems that cyclones in their neighborhood have no effect whatever on their gigantic mass of air, that may cover the area of the United States, or of Europe and Asia together. Such anomalous anticyclones bring generally much higher pressure than their wandering cousins and they last longer.

Without doubt they bring an atmosphere to our lungs quite different in quality from the one coming out of a shallow high. I may say right here that periods of increased activity in the sun bear a certain relation to the appearance of such increase of air pressure on our globe. The sun is practically the sole source of the energy which maintains the movements of the Earth's atmosphere. It is the center of a continuous outflow of radiant energy, some of which is appropriated by the earth. This outflow is more or less modified by certain periods of the sun's activity.

One of our greatest living meteorologists * has said only recently that "the problem of weather periods and their connection and dependence on the activity of the sun is one of the grandest and most beautiful problems of modern meteorology."

The highest levels of our atmosphere are more directly affected by this energy than the lower levels, and thus we have to qualify the air that flows down to us during a period of a stationary anticyclone, according to the special conditions of the sun that may have affected it. For instance, ozone is formed in the highest atmosphere consequent to the absorption of ultraviolet rays and you all know the irritating effect it may have on mucous membranes.

Then again, since radium became known to us, we became acquainted with radioactivity which is considered now a universal property of our atmosphere. A constant ionization is going on in our atmosphere, due to the radioactivity of our earth and to the work of sunrays. Radioactive influences seem to be derived principally from the pores of the earth.

Physicists, in following up this matter, found that during cyclones this radioactive influence becomes exceedingly marked in our atmosphere. The ascending air sucks the emanation out of the soil. In consequence negative electricity predominates in our atmosphere.

During an anticyclone the rising of such radioactive emanation seems more or less prevented by the increase of air pressure over the capillaries of the earth. In consequence positive electricity prevails. As we have no special sense for electricity, nor for air pressure and its variations, we do not become aware of the tremendous differences that exist in the air we breathe during different weather conditions. In general, it may be said that during a cyclone, at least during the beginning of one, the air is filled with all the impurities that possibly can be lifted and carried upward from the ground. During an anticyclone the atmosphere coming to us should represent the purest air possible, an air possessing all qualification that the sun's energy may impart. The higher the air pressure, the higher probably is the origin of such air and the more specific is such quality.

How can such relatively pure air be of detriment to our lungs? Has change of air pressure in itself any possible effect on our system? A London physician, Dr. R. Mead, wrote in 1746:[6] "The whole body, in the heaviest air (30.8 inches) sustains a weight of about 33.684 pounds; in the lightest (28 inches) of 30.622 pounds, 5 ounces. Whence the difference of pressure at different times is 3.062 pounds. True it is that the internal air of the human body makes a resistance to that weight, but yet such change of pressure must necessarily have considerable effects. Such effects must of necessity be most visible in weak bodies and morbid consti-

* I. Hann.

tutions, when other circumstances concur to their taking place, while strong bodies and sound constitutions are little affected by them."

In regard to the effect of electricty on our body, Prof. J. Loeb[7] says, that "nature had so safeguarded the electric conditions, and especially the equilibrium of electric forces within the body, that any disturbance of this by external electric force is utterly impossible. We are so constantly placed on varying electric conditions because of alterations in the electricity in the earth and the air, that if this were not the case animal life would be in almost constant danger from the magnetic storms that are so frequent."

But is it true that we are so safeguarded? Was the London physician nearer the truth in 1746, when he had his doubt about weak bodies? Is the terrific morbidity and mortality from pneumonia not perhaps a proof of an insufficient safeguarding?

Dr. W. T. Howard of Cleveland[8] had 35% pneumonia in 550 autopsies. 6% were due to primary and 29% to secondary pneumonia. He says that 50% of his autopsies on typhoid fever subjects showed pneumonia.

Any reflex action on the mucosa of the air passages may cause a hyperæmia, or such molecular changes in it, that a secondary infection may become established.[9] Whether air pressure or ozonization, or a specific ionization may cause such reflex actions, we do not know. Whether other potencies of the higher atmosphere may influence our health, we do not know.

However, these charts may demonstrate to you that during a prevalence of anticyclonic weather and especially inside the area of a stationary anticyclone pneumonia and probably la grippe are generally prevailing and sometimes become epidemic.

That temperature, sunshine and humidity are in no relation to the prevalence of pneumonia I tried to prove to you by the San Francisco chart. During the entire period of 11 years from Aug. 1, 1888 to May 2, 1899 there are only 2 great epidemics of pneumonia in San Francisco and they are representing at the same time the only two periods of excessively high air pressure that have been registered during those years.

About 340 deaths from pneumonia occurred during the continuous 9 weeks ending March 11, 1890, and about 380 deaths during the continuous 9 weeks ending Jan. 26, 1892. Not before 1890, nor after that year until summer 1904—my records go to 1904—has the mortality from pneumonia again reached such figures for any continuous 9 weeks in San Francisco.

Of course we may call la grippe responsible, but then we have to blame excessive air pressure periods for the prevalence of both diseases.

The increasing population of San Francisco, therefore, can not be blamed for an increase of the mortality from pneumonia. It seemed wise just for this reason, to compare two cities like Chicago and San Francisco in regard to their pneumonia mortality and their air pressure conditions. You are confronted on this chart with a highly interesting problem of pneumonia epidemics.

To make the comparison as direct as possible I gave on this chart the mortality figure of San Francisco five times higher than the actual one, as Chicago's population was just about five times higher than San Francisco's during that period. You see without difficulty that there are real epidemics of pneumonia in almost every year in either city, that they are not synchronous, that they are quite different in the figure of mortality in the different years and that these figures are not increasing from year to year, that Chicago's mortality comes to a very low ebb every summer, except 1903, that San Francisco has a reduced but still considerable mortality from pneumonia every summer, especially 1903, and that all these epidemics of Chicago and San Francisco are keeping most accurate pace with the increase and decrease of air pressure, as registered in these cities. If we select nine continuous weeks as a time unit of the lowest and highest mortality in either city for the five years, we find the following figures to represent mortality and air pressure:

1. Lowest mortality from pneumonia.

Days with air pressure of:	30.2 and above.	29.9 and below.	29.9-30.2
Chicago, 9 continuous weeks... Summer, 1900. Mortality, 18.3 per week.	2 days	11 days	64 days
San Francisco, 9 continuous weeks ..... Summer, 1901. Mortality, 38.2 per week.	none	18 days	59 days

2. Highest mortality from pneumonia.

Chicago, 9 continuous weeks... Spring, 1904. Mortality, 148.8 per week.	31 days	16 days	30 days
San Francisco, 9 continuous weeks ..... Winter, 1900-01. Mortality, 137.1 per week.	24 days	13 days	40 days

In this comparison I have included the air pressure figures for the 2 weeks preceding the continuous 9 weeks of lowest and highest mortality from pneumonia during the 5 years. We have, therefore, the air pressure figures for 77 days and the mortality figures for 63 days. It is obvious that this should be done and it is doubtful whether the air pressure figures should stop 2 weeks before the end of the continuous 9 weeks of mortality.

These examples make it quite clear that it is not the cyclonic, but the anticyclonic weather that is in correlation to these epidemics. Chicago had a mortality of over 19,000 during the 5 years (256 weeks) and San Francisco of over 20,000 (1328 cases more). Of course only 1-5 of this mortality gives the actual figure for San Francisco. During the cold period of the year Chicago had an average mortality of 104 per week and San Francisco 100 per week. During the warm period Chicago had 44 per week and San Francisco 58 per week.

Undoubtedly the effect of a high pressure area may become mitigated or entirely offset by an area of very low pressure following it closely and extending over a longer period. The cyclone would remove the air brought by the anticyclone.

Only the closest study of these charts will give an adequate idea of the difficulty, to prove a correlation numerically.

To the meteorologist it is clear that such air pressure figures are only makeshifts in trying to prove a period. It is impossible to prove by them just where the anticyclone gives way to the cyclone, or when the air in its quality is changing from that of the upper to that of the lower atmosphere. It is impossible to give the proper numerical expression to the value of an anticyclone in contrast to the one of a cyclone. Naturally the two areas merge imperceptibly into one another.[10] But the proposition before us is, in future to prove the character of an anticyclone by the character and the quality of its air and not only by figures of air pressure. And this is the point where research work of the medical physicist could set in.

My work necessarily has been on empirical lines, but it carries us logically to the assumption that there must be something noxious in the air that comes to us during high air pressure periods, a noxiousness that is in direct relation to pneumonia and la grippe.

The proposition before us demands, it seems, to search and to examine critically the air we breathe during different air pressure conditions, less with reference to its temperature, moisture, motion and more as to the quality that is imparted by the radiant energy of the sun, by radioactivity, ozonization or whatever physical quality there may be.

Any investigation of this nature should not be contented to prove a reciprocal relation of certain weather conditions and pneumonia and la grippe as existing in a city or on a small part of our globe, but should endeavor to prove such relation for at least one hemisphere. The southern hemisphere would necessarily show corresponding conditions.

This is exactly what I emphasized in my paper of 1894 when I pointed to the fact that the limits of high air pressure over the northern hemisphere are at the same time the limits of the prevalence of pneumonia. At that time I exhibited charts, demonstrating this fact, for Berlin, Munich, New York, Cincinnati and San Francisco, covering many years, for instance, 10 years for Berlin and 22 years for San Francisco. Likewise, I charted this correlation for St. Petersburg, London, Paris, Naples, New Orleans, Denver and Salt Lake City but, unfortunately, our great fire did away with all these charts.

Periods of excessively high air pressure appear during certain years and certain months on different parts of our hemisphere. In some years European cities will experience this condition as well as cities of the United States almost during the same month —sometimes only one continent will exhibit this feature.[11]

But epidemics of pneumonia or la grippe are always developing in consequence. The two greatest epidemics of la grippe that existed in Europe during the last century were the two of 1833-4 and 1889-90 and the entire 19th century had the highest air pressure recorded just during those two winters.[12]

I would like to close these remarks with the words of the great clinician Ziemssen who, alluding to epidemics of la grippe and pneumonia wrote many years ago: "After all we can not but assume that there must be general conditions, perhaps multiplied by local circumstances, which appear and disappear simultaneously in great expanse of space. Of what nature these influences may be, is perfectly dark. We would not be forced to think of miasm or contagion. We are more led to believe, that fluctuations of other conditions, extending over great areas of the surface of our globe at the same time, furnish an analogy."

Conclusions.

Pneumonia is not merely concomitant to the cold weather season.

Its prevalence depends on anticyclonic weather, summer and winter, on the northern hemisphere, and not on low temperature.

There is sufficient reason to assume that the quality of the air of an anticyclone changes in conformity with changes in the activity of the sun and that the prevalence of la grippe and pneumonia is subject to a specific quality of such air.

1. Pneumonia Commission American Medicine, Sept. 23, 1905.
2. Juergens, Medizienische Klinik No. 10, 1907.
3. The Principles and Practice of Medicine, by W. Osler, 1906.
4. Modern Medicine, by W. Osler, 1907, Vol. 3.
5. Influence of Atmospheric Pressure on the Prevalence of Pneumonia, by C. M. Richter, M. D. The Journal of the American Medical Association, Vol. XXIII, 1894.
6. A Treatise Concerning the Influence of the Sun and Moon Upon Human Bodies, and the Diseases Thereby Produced, by R. Mead, F. R. C. P., London, 1746.
7. Quotation.
8. The Frequency and Etiology of Acute, non-Tuberculous Pneumonia in a General Hospital, by W. T. Howard; American Medicine, Oct. 28, 1905.
9. Erkaltung und Abhartung. A. Strasser Die Deutsche Klinik. Band 1, 1903.
10. Climatology of the United States, by A. J. Henry, 1906.
11. Lehrbuch der Meteorologie von Dr. Julius Hann, 2 Aufl., 1906:
12. Sonnenflecken, Erdmagnetismus und Luftdruck von Dr. C. M. Richter Meteorologische Zeitschrift. Band 19, 1902.

Discussion.

Prof. McAdie: Dr. Richter has asked me to criticize his paper as severely as possible from the standpoint of the climatologist. Unfortunately I am not able to do that because I know that most of the data has been gathered with thorough painstaking accuracy, and that there has been no straining of the facts; and that in all of his statements concerning pressure, temperature, humidity and sunshine he has records to verify them. The weak point in the argument is that the curves are integrated curves, whereas we need the component curves of "susceptibility." If the character of the air is the predisposing factor we ought to have in our curves not the total death rate but should know more of the number of cases contracted and the recoveries. So, with the pressure curve, it is almost impossible to determine from an integrated curve the individual component curves desired. As Dr. Richter says, in regard to the difficulties of his paper, it is almost beyond the power of a meteorologist to give a proper characteristic pressure con-

dition; for we have all kinds of pressure conditions. We may have a high pressure with everything favorable, upon this supposition, for the development of pneumonia and right in the middle of it the opposing condition will occur. How can you correlate such conditions? From the standpoint of the climatologist I think that too much importance may be given to climate. It is a double-barreled proposition. You have climate and you have man. You must remember that one man will get pneumonia because of imprudent exposure and the other man, properly housed and cared for, will not have pneumonia. There you have climate control. In Chicago you may have the same climate, the same pressure say, yet the houses may be warm, and a man stepping out of his house may walk in slushy streets, or get into an environment favorable for pneumonia. I wish to pay tribute to the work Dr. Richter has done. This is in many ways a memorable paper. It opens up a wide field of investigation. He traces a relationship between pneumonia mortality and high pressure conditions that seems to be more than an accidental relation. He has done the work with great detail and with great labor, trying to trace the relationship between the demonstrated high air pressure condition and the prevalence of pneumonia. Dr. Richter has done a great deal of thoughtful and honest work and has opened up an important line of investigation for the medico-climatologist.

Dr. Richter (closing): This chart, exhibiting epidemics in Chicago and San Francisco during 5 years, I thought would interest you, first, because we practitioners have been taught that pneumonia is a disease, more or less under the influence of low temperature, that it spreads itself generally over the cold season of the year and that it is an infectious disease, which calls for a certain prophylaxis in regard to sputum. On this chart you find that, although pneumonia is more prevalent during the cold season, it appears in the form of epidemics of different magnitude in the different years, seasons and cities, and is entirely independent of low temperature, as the conditions in San Francisco exemplify. Secondly, we learn from this chart that these epidemics are a function of the prevalence of anticyclonic weather and I tried to lay all possible stress on the proposition to look for an explanation not in the mechanical pressure of the atmosphere, but in possible qualities of the air, as carried to us during an anticyclone from the higher levels. Such air should be supposed to be qualified by the radiant energy of the sun and to a different degree during the different periods of the sun's activity.

REVIEW OF RECENT WORK ON TUBERCULOSIS.*

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The purpose of this paper is briefly to report some of the most important articles, which have appeared during the past year upon the subject of tuberculosis. No attempt has been made to report them all for that would clearly be impossible, but a resume of the work which has been done along the lines of etiology and diagnosis should serve to show the trend of modern experimental research in the field and to point the way to a better understanding of modern treatment.

Under the heading of etiology the statement of Koch, made before the London International Congress of 1901, that the human species was not subject to infection by the bacillus causing bovine tuberculosis takes first place in importance and interest. To settle this question a royal commission was appointed consisting of Sir Michael Foster, Woodhead, Martin, McFadyn and Boyce, whose second interim report (1) published in February, 1907, gives the results of their labors to this time. While their work is not by any means completed, it is evident from this report that their experiments are being made in the most thorough and scientific manner, and it is already quite apparent at what conclusion they will eventually arrive.

Their experiments with bovine tubercle bacilli were performed upon guinea pigs, dogs, cats, rabbits, goats, apes, baboons and monkeys, and the organism was found to be fatal to all these animals as well as to the bovine species and to act upon them in the main with neither more nor less virulence.

The human bacilli worked with fall into three groups. Group I resembles the bovine type in cultural characteristics and virulence upon the animals mentioned. They grow with difficulty upon artificial media as the bacilli of the bovine group do. After an injection of equal doses the animals used develop rapidly fatal general tuberculosis equally with those infected with the bacilli of the bovine group. In other words, Group I is the bovine bacillus and nothing else.

Group II are far less virulent to animals in the doses used than those of Group I. They grow easily upon artificial media. In comparatively large doses a rapidly fatal general tuberculosis does not follow in dogs, cats, guinea pigs, etc., while, on the other hand, when monkeys, apes and baboons are used a comparatively small dose is followed by rapidly fatal effect. The important fact is thus shown that their virulence increases as the animals used approach the human type.

Group III is intermediate in virulence between Group I and Group II. It lies between the two in cultural characteristics, and it is generally unstable and variable in its virulence.

In conclusion, the committee say: "Of the sixty cases of the human tubercle bacilli studied by us fourteen belong to Group I, that is to say, contained the tubercle bacilli of the bovine type. Of these sixty cases twenty-eight possessed clinical histories indicating that in them the bacillus was introduced through the alimentary canal. Of these, thirteen belonged to Group I. Of the nine cases in which cervical glands were studied by us 3, and of the nineteen cases in which lesions of abdominal tuberculosis were studied by us, 10 belonged to Group I. These figures indicate that a large per cent of tuberculosis contracted by ingestion is due to the bovine

* Read before the Cooper College Science Club, March, 1908.